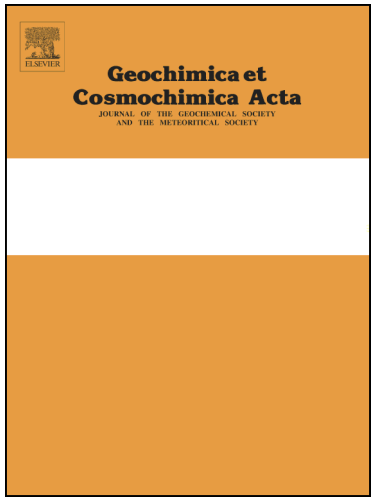

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Experimental calibration of a new oxybarometer for silicic magmas based on vanadium partitioning between magnetite and silicate melt

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Abstract

Partition coefficients of vanadium between magnetite and rhyolitic silicate melt, $D_V^{mgt/melt}$, were experimentally determined as a function of oxygen fugacity (0.7-4.0 log units above the fayalite-magnetite-quartz buffer), temperature (800-1000 °C), melt aluminum saturation index (ASI=0.74-1.14), magnetite composition (0.2-14 wt% TiO_2) and pressure (1-5 kbar; at H_2O saturation). Experiments were performed by equilibrating small (≤20 μm), V-free magnetite grains in V-doped silicate melts (~100 ppm V) and then analyzing both phases by LA-ICP-MS. Attainment of equilibrium was demonstrated by several reversal experiments. The results suggest that $D_V^{mgt/melt}$ depends strongly on fO_2, increasing by 1.5-1.7 log units from the MnO-Mn_3O_4 buffer to the Ni-NiO buffer, and to lesser (but still considerable) extents on melt alumina saturation index (ASI; increasing by 0.3-0.7 log units over 0.4 ASI units) and temperature (increasing by 0.3-0.7 log units over a 200 °C interval at a fixed fO_2 buffer). Magnetite composition and melt water content seem to have negligible effects. The data were fitted by the following linear regression equation:

$$\log D_V^{mgt/melt} = 0.3726 * \frac{10{,}000}{T} + 2.0465 * ASI - 0.4773 * \Delta FMQ - 2.1214$$

, in which temperature is given in K, ASI refers to molar $Al_2O_3/(CaO+Na_2O+K_2O)$ and ΔFMQ refers to the deviation of fO_2 (in log units) from the fayalite-magnetite-quartz buffer. This equation reproduces all of our data within 0.3 log units, and 89% of them within 0.15 log units. The main advantages of this new oxybarometer over classical magnetite–ilmenite oxybarometry are (1) that it can be applied to rocks that do not contain ilmenite, and (2) that it is easier to apply to slowly-cooled rocks such as granites.

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